

How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE, WASHINGTON, D.C.

No. 4

**How To Remove and
Overhaul the Chassis**

RADIO SERVICING METHODS



NRI TRAINING

Pays...

Dear Mr. Smith:

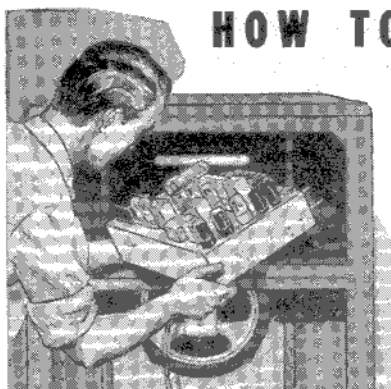
I made money before completing your Course by doing spare time Radio work. In May I opened a Radio repair store, and in about two months time there were about 150 radios ahead of me. In August I hired a Radio technician to help me. During the past year my profits were approximately \$3600. All I had was the will to get ahead — NRI furnished the rest. This Course includes everything to make a man tops in Radio.

R.B.F., Michigan



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**NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.**



HOW TO Remove AND Overhaul THE Chassis

ALMOST every time you repair a radio, you will have to remove the chassis from the cabinet to locate and replace the defective part. In some receivers (particularly small portables), you must even do so to remove the tubes for testing. Now removing a chassis may seem to be a simple job—yet, even when you know how, “pulling” the chassis can easily take longer than the actual repair!

In this Booklet, we shall give you practical hints on how to remove the chassis rapidly. In addition, you will learn how to overhaul a chassis so that it will be in first-class condition when you have made the repair and put back the chassis in the cabinet. Study this information carefully—it will help you to service *faster and better*.

First, let's learn how to remove a chassis.

GENERAL PROCEDURES FOR REMOVING THE CHASSIS

There are three types of cabinets: the midget, which includes the portable; the table model, a receiver of medium size that is set on a table or bench; and the console, a big cabinet that stands on the floor and may also include a phonograph. We will take up each type in turn. But, before we do, let's learn some general procedures that apply to all three.

► Before you attempt to remove or reinstall a chassis, *always unplug the receiver power cord from the power outlet to prevent the possibility of shock*. Then take a few minutes to look over the receiver and study its ar-

rangement. Usually the fastenings will be simple.

As your first step, remove the control knobs. (These knobs fit on the ends of the control shafts which come from the chassis through the front panel of the cabinet.) The exact method of removal depends on the fastening. Some knobs have set screws; others are held on by friction springs. Just pull off the latter type. Further examination will show whether you must remove push buttons, dial pointers, etc.; instructions for removing these are given later.

Next, turn the cabinet around and look for speaker cables, power wires, antennas, etc., that have to be disconnected. Sometimes you will find it more convenient to disconnect these after the chassis has been wholly or partly removed from the cabinet. Some receivers have back covers or loop antennas that must be removed.

Next, locate the chassis fastenings. There should be screws or bolts holding the chassis in the cabinet, and sometimes shipping bolts or clamps used to protect the receiver in transport from the factory may still be in place. (On the other hand, another serviceman may have left off the securing bolts, so be sure never to tilt a cabinet until you are certain that the chassis is securely fastened in it.) Most sets have a straightforward arrangement of two to four screws or bolts, but some have "hidden" screws. Sets with inclined tuning dials, or those in period style console cabinets, sometimes have extra screws holding the tuning mechanism in place.

Once you have located the fastenings, remove them and lift the chassis out of the cabinet. If it sticks, *do not force it*. Pull and lift cautiously to learn where it is being held. Many sets stand on rubber "feet" or blocks, which are used to reduce vibration. These blocks may stick, particularly when placed in counter-sunk holes, and will have to be pulled or pried loose.

► Let's sum up the steps in removing a chassis:

1. Unplug power cord.
2. Remove control knobs.
3. Remove push-button knobs *if necessary*.
4. Remove dial pointer, dial scale, or dial cord connection to pointer *if necessary*.

5. Remove back cover or loop antenna *if in the way*.
6. Disconnect speaker cable, antenna and ground leads, phonograph cables, etc., *when necessary*.
7. Remove chassis bolts and take out chassis.

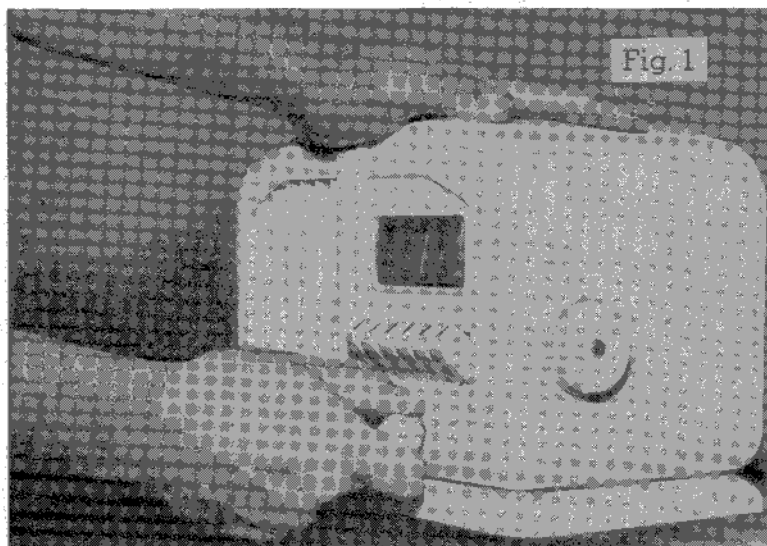
► Now, we'll see how these steps apply to specific models. Remember that the *methods* we discuss will apply to *any similar case*, whether the cabinet is a midget, table, or console type. Thus, we may describe the removal of a certain type of knob under "midget sets," but this would apply to similar knobs on any set. Also remember that we are describing only representative types—we could not possibly cover them all.

REMOVING A MIDGET CHASSIS

Fig. 1 shows a midget receiver in a plastic cabinet. This universal a.c.-d.c. set has a manual tuning knob or wheel on the right-hand side. The knob on the front is the volume control and ON-OFF switch. Push buttons for automatic tuning are above this knob.

► The first step in removing the chassis is to take off the knobs. This will allow the shafts to slip out of their cabinet holes when the chassis is removed.

There are three methods of fastening control knobs to shafts. There may be a set screw in the side of the knob which, when tightened, bites into the shaft; the knob may be held on simply by friction; or, as is the



case with the tuning knob in Fig. 1, a screw may pass through the knob and into the end of the shaft.

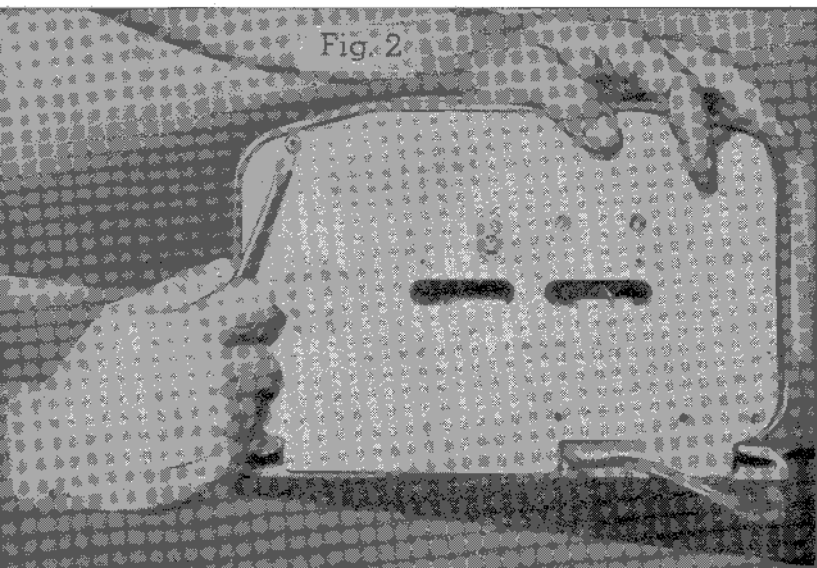
To remove a knob held by a screw, simply loosen or remove the screw and pull off the knob. If no screw is used, then the knob is held on by friction. **TO REMOVE ANY FRICTION TYPE KNOB, JUST GRASP IT FIRMLY AND PULL IT OFF.** Hold the cabinet with the other hand, as illustrated in Fig. 1.

Now remove the main tuning knob which projects from the side of the cabinet in the set shown in Fig. 1. A screwdriver is the only tool required. On many sets of this kind, releasing this knob also releases the locking mechanism for the push buttons. The push buttons will then probably get out of adjustment and will have to be reset. Details on resetting push buttons will be given in a later RSM Booklet.

As you take each part off the cabinet, put it in a small box so that it will not be lost, and you won't have to waste time looking for it when you reassemble the receiver.

► Next, remove the back cover, if one is used. In most cases four screws will hold the back in place on the cabinet. If a wooden cabinet and wooden back are used, a number of wood screws may pass through the back into the edges of the cabinet. However, in our example, snap fasteners are used instead of screws. They pass through

Fig. 2



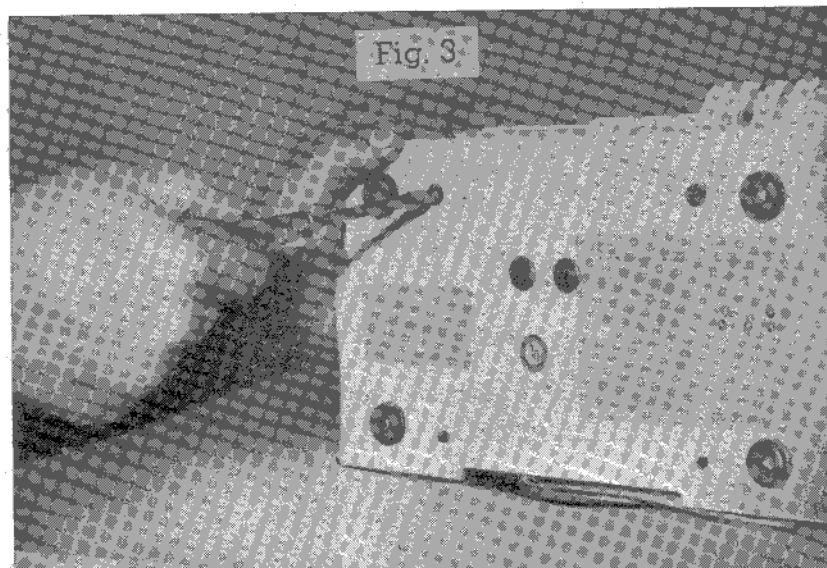
holes in the back and snap into holes provided in the cabinet. Fig. 2 shows how you can pry out these snap fasteners with a screwdriver blade.

After the back cover is loose, tilt it back to see if a loop is mounted on it. If one is, it will be wired to the chassis, and you must be careful not to break the connecting leads. Sometimes you can leave the loop attached to the chassis, sometimes you'll have to disconnect it—but you should never rip it loose.

► Examine the back of the chassis to see how it is held in the cabinet. In our example the mounting bolts pass through the bottom of the cabinet into the chassis (see Fig. 3). Here, the cabinet has been turned on its back so the mounting bolts can be removed with a screwdriver. (Sometimes hex-head bolts are used; remove this type with a socket wrench.) Take out the lower bolts first, allowing the chassis to hang from the upper ones. If you take out the upper bolts first, the chassis will tend to twist in the cabinet and may jam.

► Notice, on the bottom of the cabinet, the chart giving the positions of the tubes and the make and model number of the receiver. In some cases, you will find a complete wiring diagram on the bottom of the cabinet.

As you take out the last mounting bolt, put your hand under the back of the cabinet. Hold the chassis up to prevent it from dropping out of the cabinet. Next, place



the cabinet right side up with the back toward you. Hold the cabinet with one hand while you pull the chassis out with the other. Pull on a coil can or some other rigidly mounted part that won't be crushed or damaged.

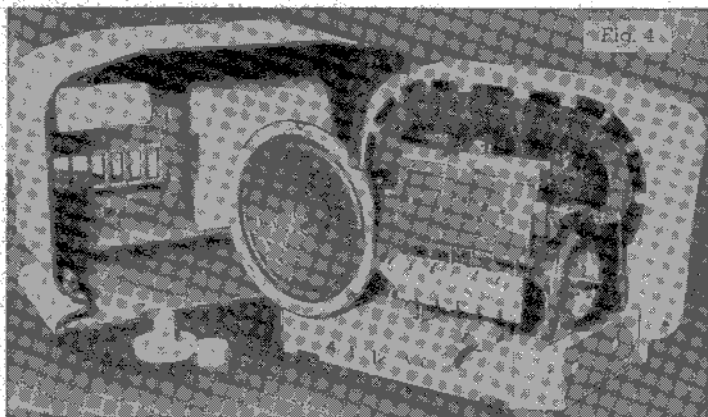
Fig. 4 shows the chassis out of the cabinet and ready to be serviced. The numbers stamped on the front chassis wall are inspection numbers which do not identify the chassis. The model number of this receiver is on the label on the bottom of the cabinet.

The set shown in Fig. 4 has the speaker mounted right on the chassis, so it does not remain in the cabinet. This is generally true in midsets; however, in larger receivers, the chassis and the speaker are mechanically separate and are connected electrically with a cable.

In Fig. 4 the hardware (knobs, snap fasteners, and screws) have been grouped together on the workbench so that you can see them. On an actual job, you'd put each part in a container as you took it off.

► The push buttons on the set pictured did not have to be removed, but in some receivers, like the one shown in Fig. 5A, it is necessary to remove the push buttons before the chassis can be taken from the cabinet. The push buttons shown in Fig. 4 could be pulled off if necessary, but those in Fig. 5A have to be unscrewed in order to remove them, as shown in Fig. 5B. In each case a preliminary examination will show you what must be done and how to do it.

The midset shown in Fig. 5B is somewhat different



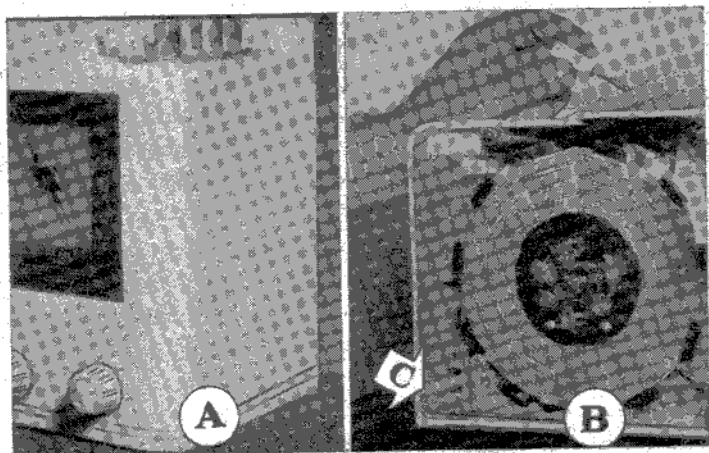


FIG. 5. In most sets the chassis can be removed without removing the push buttons, but in some sets like the one shown here, push buttons must be removed first. Find out which kind you have before removing the chassis.

from the one in Figs. 1 to 4. Instead of screws through the bottom of the cabinet, the chassis is held in place by the bolt marked *C* in Fig. 5*B* and by another one on the opposite end of the chassis. Also, it does not have a back cover but it does have a loop. This loop can be removed to make it possible to remove tubes for testing without pulling out the chassis. The loop is held on by two screws. If the chassis is to be taken out for servicing, the loop can remain in place.

► In still another type of midget, the tuning dial pointer slips over a shaft that protrudes through the front of the cabinet. The pointer is held in place by friction and must be pulled off before you take the chassis out of the cabinet. You will find many variations like this—watch for them.

REMOVING A TABLE-MODEL CHASSIS

Table-model receivers are larger than midgets, but are in cabinets designed to be placed on tables or shelves. Remove the control knobs first. If you find a set screw holding a knob, rotate the knob to make sure there aren't two screws—some early receivers used them.

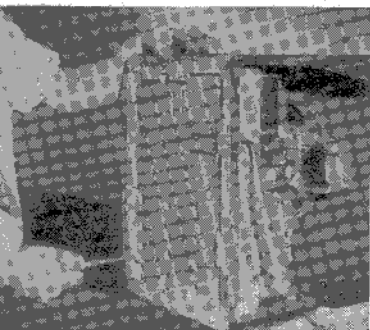


FIG. 6.

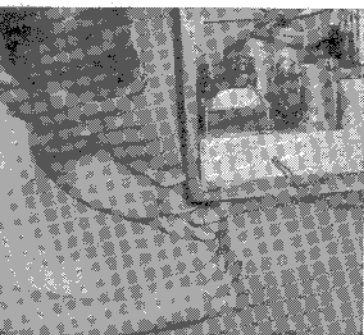


FIG. 7.

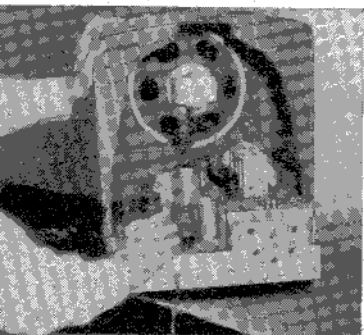


FIG. 8.

Next, turn the cabinet on its side and *loosen* the four mounting bolts as shown in Fig. 6. Don't take them out completely—if you do, the heavy chassis may fall over inside the cabinet, and some parts may be damaged.

After the mounting bolts are loosened, set the cabinet upright on the workbench with one edge of the cabinet sticking out over the edge of the bench, as shown in Fig. 7. Remove the mounting bolt thus exposed, then repeat the process to remove the other mounting bolts.

Next, grasp the power transformer (or some other large, firmly mounted part), and pull the chassis out of the cabinet (Fig. 8). If you look closely at this figure, you can see the cable that connects the loudspeaker and the chassis. If the cable is long enough, you may not have to remove the speaker from the cabinet. If you wish, you can unplug the speaker cable, *but be sure you NEVER turn on the set with its speaker disconnected.* (As you will learn later, this may damage the set.) On this set, the connecting plug is mounted on the speaker; sometimes you will find it on the back, the side, or the top of the chassis. Some sets have no plug in the speaker cable.

► When the cable is not long enough to let you take the chassis out of the cabinet and work on it readily, the loudspeaker must be removed. To remove the loudspeaker, loosen the nuts around the back of the speaker

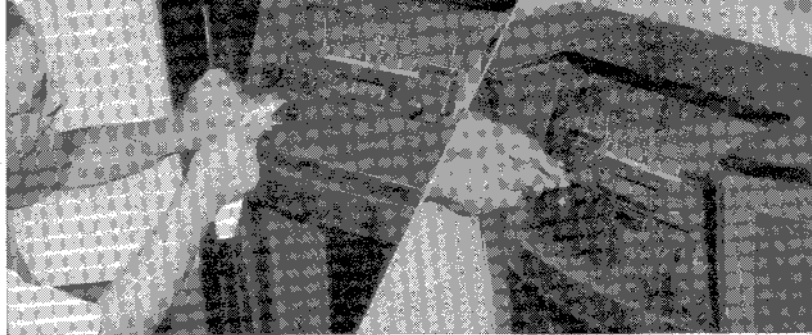


FIG. 9 (left). Here is an easy way to remove a stuck knob.
 FIG. 10 (right). One step in removing the dial scale. This step is not necessary in some sets.

rim with a socket wrench. Hold the speaker in place with your hand while taking off the last nut. Then, grasping the magnet frame, pull it straight back, and place it face down on the workbench on a clean piece of paper. Be careful not to puncture the speaker cone by putting it on some sharp object.

When you reinstall the speaker, be very careful to line up the holes in the speaker rim with the proper mounting bolts. Carelessness in reinstalling the speaker will allow the mounting bolts to punch holes in the speaker cone. If the cable is short, turn the speaker so that the cable will be long enough to reach from set to speaker when both are reinstalled. If the output transformer is mounted on the speaker, be sure it is placed so that it will clear all chassis parts when the chassis is slipped in place.

REMOVING A CONSOLE CHASSIS

Fig. 9 shows part of the front of a console receiver. All knobs must be removed. These knobs are usually of the friction type. In this particular case, the knob is stuck and will not come off easily, so the serviceman has folded a handkerchief and slipped it under the knob. By pulling on the ends of the handkerchief, he can remove the knob without trouble. This is a trick to remember—you'll find it handy time and time again.

On this model, the dial pointer must be removed. Its operating mechanism protrudes through a slot cut in the cabinet. Fig. 10 shows how the dial scale is removed so that the dial pointer may be disconnected from the



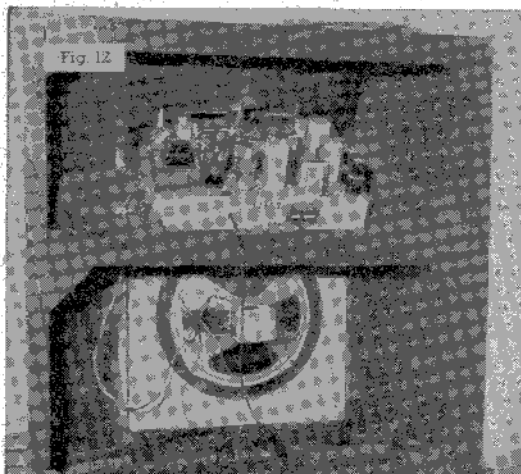
FIG. 11. Removing the dial scale pointer. This is not necessary in all sets, but must be done in this one so that the pointer will not be bent when the chassis is removed.

chassis tuning mechanism. The scale is held in place by four wood screws. (Watch for Phillips screws here; these require the use of a small Phillips screw-driver.) When these screws have been removed, slip off the dial scale. Then, as shown in Fig. 11, remove the dial pointer by loosening the screw that holds it at its bottom. The dial pointer will be bent or broken if you pull out

the chassis without removing the pointer first.

Fig. 12 shows a back view of the chassis. The speaker is in a compartment below the chassis. So is the loop antenna, which is inside the cardboard form that surrounds the speaker. Cable leads pass from the speaker and the loop through holes in the chassis mounting-board and plug into jacks on the left-hand side of the chassis. *Never cut a cable that passes through a hole in the cabinet.* You will always find a plug at one end of the cable. Disconnect such plugs, making careful note of where each goes.

Now take out the bolts holding the chassis to the wooden shelf. You'll probably have to lie on the floor so



that you can see the bolts and get a large screwdriver into them, as shown in Fig. 13. Before the last bolt is completely removed, put your hand on the back of the chassis so that it can't slide down the inclined shelf and fall on you or the floor. Fig. 14 shows the chassis being slid out of the cabinet.

In a few receivers, you will find that the dial is mounted on the chassis and also is screwed to the front of the cabinet to give it greater rigidity. If, when you start to pull the chassis out of the cabinet, you find that it is being held, don't just pull harder. Stop and see what's holding it. If the dial is screwed to the cabinet, remove the screws.

► Notice the tools and parts left on top of the cabinet in Fig. 14. This is something that should never be done, for the top of the cabinet may be scratched, and no housewife is going to like the idea even if the cabinet isn't damaged. It is best to replace all tools in the toolbox as soon as you are finished with them, and to place knobs and screws in a container (a small jar, can, or box carried in your tool kit).

Installing a chassis of this kind is much easier than taking it out, because generally you don't have to lie down on the floor. You can tell from the old dust marks or press marks just how the chassis was placed originally in the cabinet, and when you have it exactly in place, you can easily start the chassis mounting bolts with your hand and finish up with a screwdriver. By feeling with your fingers, you can slip the screwdriver blade

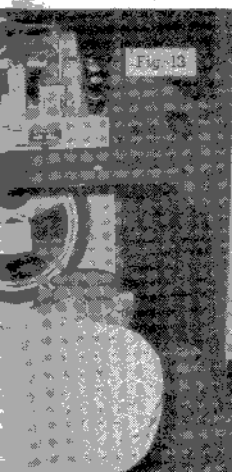


Fig. 13

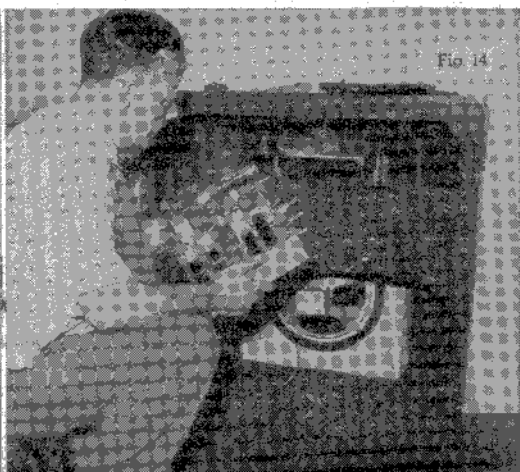
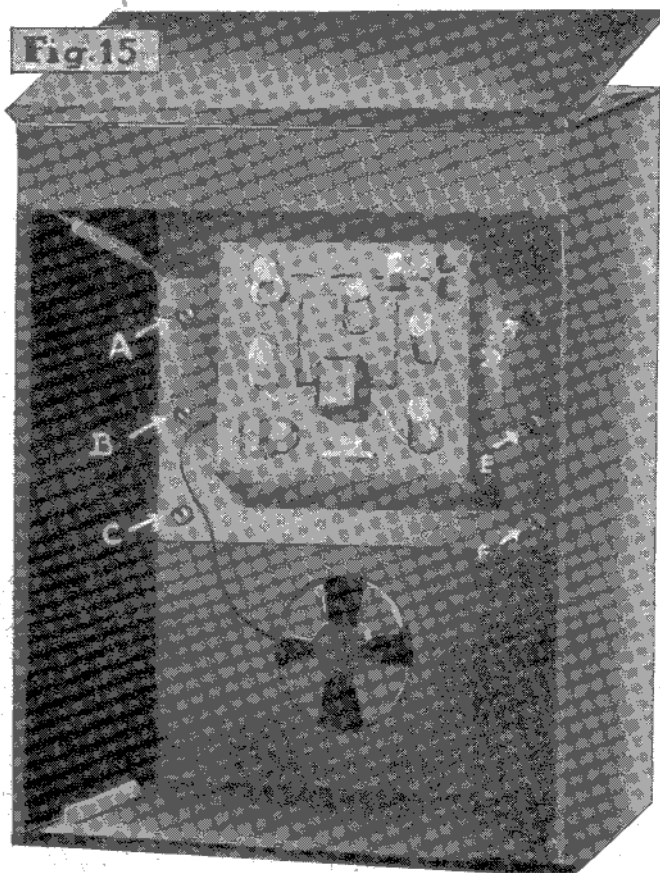


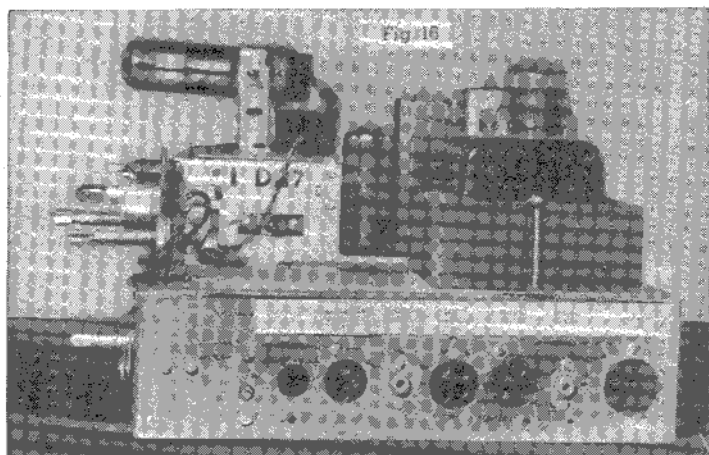
Fig. 14

into the screw head slot without much trouble.

► In some receivers, the control knobs stick up through the top of the cabinet. In this instance, the chassis may be mounted on a baseboard, as shown in Fig. 15. This baseboard will be screwed to the front of the cabinet. Loosen the screws *A-B-C-D-E-F* one at a time, taking out first those that are hardest to reach. These are usually the ones in the top. Hold the chassis with one hand or put books or blocks under it to hold it in place while you take out the last screws. Lift the chassis out of the cabinet. You can then lay the chassis on its back or on its side and take out the bolts that fasten the mounting board to the bottom of the chassis.

Fig. 16 shows a side view of a chassis designed for





many uses. It can be used as a small public address system by plugging a microphone into the jack provided for this purpose, or it can be used to amplify the output of an electrically-operated phonograph. Note the number of jacks and sockets for the various attachments. You will not always find a label pasted on the chassis indicating the use of each jack. It's a good idea to look first, and, if there is no label, to mark with a pencil on the side of the chassis the position occupied by each plug you remove. Then you will have no trouble in getting the right plug back in the right jack.

Of course, if you can look at the side of the chassis when you are ready to put back the plugs, you won't have much trouble, since the plug pins generally are arranged in such a way that they will fit only into the proper jacks. If you can't see the jacks, however, you may do considerable fumbling around before you get the right plugs into the right jacks, so a sketch of some sort will save you time.

In a few receivers, you will find that the leads from the phonograph motor are soldered inside the receiver chassis instead of being plugged into a socket (look for a plug at the motor). When there is no plug, these leads must be cut before you can take the chassis out of the cabinet. Be sure that the receiver is disconnected from the power line before you try to cut these leads with your side cutters. It's best to stagger the cuts on the

two wires, as shown in Fig. 17A, instead of cutting them both at the same place. When you reassemble the receiver, strip the insulation off these four wires, reconnect them with twist connections (Fig. 17B), solder the joints, and cover them with tape (Figs. 17C and 17D).

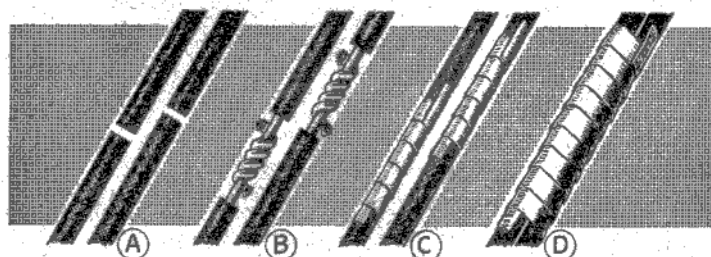


FIG. 17. Four steps in making a splice.

Overhauling Radio Receivers

Regardless of the complaint for which the receiver is being serviced, certain general overhauling steps should be taken while the receiver is out of the cabinet. These steps are simple ones—removing dust and dirt, resoldering poor connections, replacing pilot lamps, etc.—but they all have a bearing on the appearance and operation of the receiver. Let us see just what you should do. We will assume that the chassis and the speaker have already been removed from the cabinet (in the manner given earlier in this Booklet).

Cleaning the Chassis. A thorough cleaning is part of every service job. There is always an accumulation of dust on a radio, for its heat of operation sets up air currents that carry dust to it. Furthermore, the average housewife is afraid to clean the inside of a radio for fear of possible damage to the radio (and, perhaps, shocks). A set owner may be embarrassed by the dirty appearance of his radio, and he is certain to notice and appreciate its return in a clean and shining condition.

There are technical reasons for cleaning, too. Moisture is the greatest enemy of a radio receiver, and dust tends to collect and hold moisture. When dust gets between the plates of a tuning condenser, it causes noise.

Dust is somewhat conductive, so dust can provide leakage paths between circuits.

For these reasons, and to be able to work under the cleanest conditions possible, remove all dust as one of your first service steps when the receiver is in your shop. (In the home of the customer, don't raise a dust storm in the living room. It is preferable to carry the dusty receiver out with you; avoid cleaning inside the home if possible.)

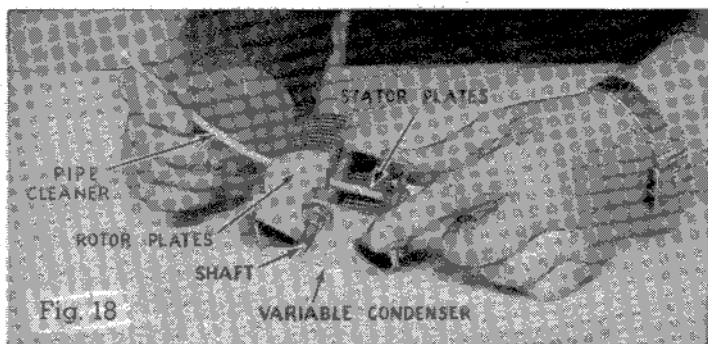
To keep your shop and yourself clean, wear a shop apron, and do your cleaning outdoors if possible. Don't inhale dust. Provide plenty of ventilation if you must clean up indoors.

Dust may be removed by wiping, by blowing, or by vacuuming. Outdoors, you could use a small bellows, bicycle pump or vacuum cleaner hose attachment to blow away most of the dust. Indoors, it is best to wipe the chassis with a clean cloth or with a small clean paint brush.

► Next, remove the tubes, *one at a time*, wiping off all dust with the cloth. If the tube base prongs appear corroded, clean them with fine sandpaper. Wipe the top of the tube socket and the chassis in its vicinity, then replace the tube. Repeat the process on each other tube in turn. *Never take out more than one tube at a time*, or you may get them mixed and replace them incorrectly.

Quite often a tube will be surrounded with a metal can known as a tube shield. One type of tube shield is removed by pulling upward (if there is a connection to a top cap on the tube, remove this first). Another type, made in two parts and known as a form-fitting shield, is held together by a spring-steel ring. Pull out the tube and shield together, then push this ring out of its groove with a screwdriver; the shield will then fall apart and can be removed easily for cleaning.

► It is most important that all dirt be removed from the variable condensers. Rotate the gang tuning condenser to its open or minimum-capacity position and run a pipe cleaner (the type obtained from tobacco stores) between each pair of plates to loosen the dirt,



then blow out any dust that remains. Fig. 18 shows the method. (The condenser was removed from the chassis for clarity in this illustration, but, of course, you should not remove the condenser to clean it.)

Any grease or dirt remaining on the chassis after the dusting procedure should be removed with a cloth dipped in a cleaning fluid such as carbon tetrachloride (Carbona). NEVER USE WATER ON A RADIO CHASSIS! Clean the tuning dial with a soft dry cloth.

Tightening Screws. It is rare indeed to find any "loose" screws on a radio receiver *except trimmer adjusters*. Many beginners find these, tighten them, and then find that the receiver no longer functions. An expert must be called in to realign the receiver—in practically all cases a signal generator must be used. Therefore this **WARNING:** *Do not blindly tighten every screw head and nut you see on a chassis; a great many of these screws and hex-head bolts or nuts are for tune-up or alignment purposes; they control the settings of trimmer condensers or adjustable coils.* You can recognize these screws by the simple fact that they are mounted *ON* a part and *do not* serve to fasten that part to the chassis. A few typical alignment screws are shown in Fig. 19. Some parts, even, are not supposed to be secured *tightly* to the chassis; tuning condensers, for example, are frequently mounted on rubber "feet." Therefore, there is rarely any necessity for tightening mountings unless you have loosened them for some testing purpose.

Soldering. Be sure to notice the condition of the

soldered joints. Manufacturers use good soldering techniques, but you can never tell what some other serviceman has done. Resolder any joints that appear to be defective—joints that have a green and corroded appearance, joints covered with excessive rosin, and joints over which the solder did not flow smoothly. You can test joints for looseness by pulling on the wires with a pair of long-nosed pliers.

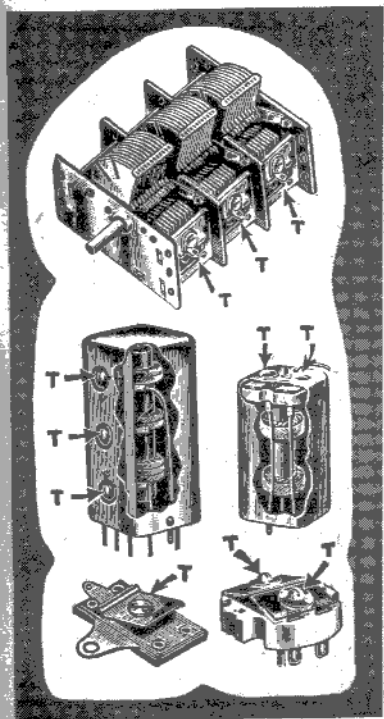
Insulation. Be on the lookout for frayed or cut insulation, particularly on wires that go through the chassis. If you find a lead with defective insulation, replace it with a new lead; or wrap insulating tape over it; or unsolder one end and slip a piece of varnished cloth tubing (called "spaghetti" by radio men) over the wire so it will cover the break in the insulation, then resolder the lead.

Inspect the power cord for defective insulation, particularly at the point where it enters the chassis and at the wall plug. The rubber insulation on power cords will

dry out and crumble with age. Replace any cord in poor condition, because such a cord is a fire hazard.

Examine the leads on top of the chassis going to the tube top caps. Polish the grid lead clips with sandpaper or scrape them with a knife, squeeze, and adjust them so they make firm contact with the top caps of the tubes. Be sure that each tube shield makes good contact with the chassis, and that the grid leads do not touch the shield.

FIG. 19. Typical locations of alignment screws on: tuning condensers; i. f. transformers; and trimmer condensers. Never tighten or loosen these screws; they are used to adjust tuned circuits, not to hold the parts to the chassis.



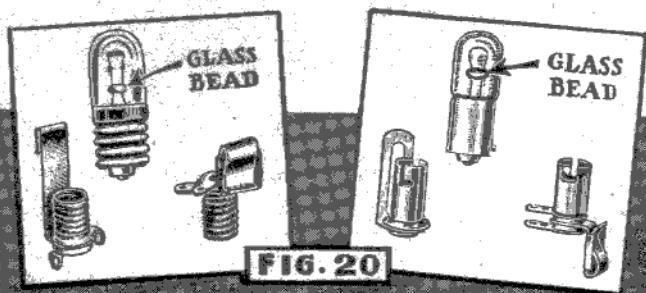
REPLACING PILOT LAMPS

Nearly all radio receivers use pilot lamps to illuminate the tuning dial and to indicate that the receiver is "on." Like any lamps, these burn out with either age or overloading.

The two types of pilot lamps most widely used are shown in Fig. 20. The miniature screw-base lamp shown at A is like a flashlight bulb. The miniature bayonet-base lamp at B has a smooth metal base with two side studs, like an automobile dash lamp. Typical sockets for these pilot lamps are shown with them.

Removing a Pilot Lamp. Pilot lamps can usually be removed by reaching in from the rear of the radio cabinet. In some cases, however, (particularly in midget receivers), it is necessary to remove the chassis from the cabinet to get at the pilot lamp. (In the receiver shown in Fig. 11 you can see that the dial scale may be removed to replace the pilot lamps.)

Always make sure that a pilot lamp fits tightly in its socket before declaring it burned out, for the lamps often become loose. If the socket seems oversized, squeeze it a little with your fingers or pliers to get a tighter fit. You can remove screw-base lamps by twisting them in a counter-clockwise direction; bayonet-base lamps by pushing them down slightly and twisting them a small amount counter-clockwise, just as automobile lamps are removed. Some sockets are held on brackets by spring clips. When you find a socket of this type, just pull the entire socket off its mount if that will make removal of the lamp easier.



Pilot Lamp Ratings. Pilot lamps are rated for certain supply voltages, and also for the amount of current needed for proper illumination.

Typical operating voltage ratings are 2, 2.5, 3.2, and 6.3 volts, and a few new lamps with these ratings are usually carried by servicemen in their tool boxes. The voltage rating is usually marked somewhere on the lamp; a burned-out lamp must, naturally, be replaced with a new lamp having the same voltage rating. (The 6.3-volt lamps are marked 6-8 volts, which indicates that the lamps will work on any voltage between 6 and 8 volts.)

Different current ratings are also available; typical values are .06, .15, .2, and .25 ampere. To distinguish lamps according to current ratings, the small glass beads (see Fig. 20) supporting the filaments are colored. There are three common values of 6.3-volt bulbs; a brown bead is used to indicate .15 ampere, a white bead for .2 ampere, and a blue bead for .25 ampere.

Battery sets rarely use pilot lamps. However, a few of the 2-volt types do use the 2-volt, pink bead, .06-ampere bulb. An extra switch is used to turn on these bulbs when they are needed for tuning; otherwise they are turned off to save the batteries. Don't presume these bulbs are burned out if they are not lit, at least until you have operated the lighting switch.

► On *a.c. sets with power transformers*, the most important rating for the pilot lamp is its voltage. (You will learn how to identify power transformers later.)

If the markings on a defective lamp are not clear or are missing entirely, you could measure the voltage at the lamp socket terminal with the a.c. voltmeter in your multimeter. Choose a lamp having approximately the same voltage. However, a higher-voltage lamp is quite satisfactory if it gives sufficient light, and will have considerably longer life than a lamp rated lower than the measured voltage. Thus, the 3.2-volt lamp was developed to operate on 2.5 volts, giving adequate illumination and longer life.

In *a.c. receivers* using power transformers, the filament voltage ratings of the amplifying tubes are a di-

rect guide to the pilot-lamp voltage rating, because in most cases the pilot lamp is operated from a filament winding. This means that the pilot lamp will have the same voltage rating as these tube filaments. However, since there are only two standard a.c. voltages in receivers using power transformers (2.5 volts and 6.3 volts), you could use an elimination procedure. First try a 6.3-volt lamp. If it lights very dimly, then try a 3.2- or 2.5-volt type. In practically all cases, any current rating (any color of glass bead) will do.

► *Universal receivers*, which can operate from either a.c. or d.c. lines, require special consideration. Don't try to measure the voltage across a pilot lamp socket in one of these receivers, because the voltage will be far higher than normal until the pilot lamp is installed. You will learn why this is so in your *Lessons in Fundamental Radio Principles*. The pilot bulbs used are rated at 6.3 volts, but the current rating is quite important because of the special circuit used.

If you can be sure no one has previously installed the wrong lamp, you can put in a replacement having a glass bead of the same color. If there is any doubt, however, the proper size must be determined from the service information on the receiver.

Finishing the Job. The foregoing overhauling procedure may be carried out before or after the repair of the defect, as circumstances may require. (Future RSM Booklets will discuss repairs in great detail.) However, check the receiver operation to be sure everything is normal after these procedures. Then, replace the speaker and the chassis in the cabinet by reversing the steps of removal. After doing so, polish the outside of the cabinet carefully with a good grade of furniture polish.

The receiver can now be returned to its owner with both its appearance and its operation improved. Connect it to its antenna and ground, plug in the power cord and make a final check of its operation. If it performs properly, then you have completed a service job—one of which you can well be proud!